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(11) **EP 1 103 456 A2**

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:  
30.05.2001 Bulletin 2001/22

(51) Int Cl.7: B62M 25/08, B62M 9/12

(21) Application number: 00830723.3

(22) Date of filing: 31.10.2000

(84) Designated Contracting States:  
AT BE CH CY DE DK ES FI FR GB GR IE IT LI LU  
MC NL PT SE  
Designated Extension States:  
AL LT LV MK RO SI

(72) Inventor: Campagnolo, Valentino  
36100 Vicenza (IT)

(74) Representative: Notaro, Giancarlo et al  
c/o Buzzi, Notaro & Antonielli d'Oulx srl,  
Corso Fiume 6  
10133 Torino (IT)

(30) Priority: 23.11.1999 IT TO991023

(71) Applicant: CAMPAGNOLO S.R.L.  
I-36100 Vicenza (IT)

(54) **Gear shift device for bicycles**

(57) A motorized bicycle gear shift device comprising a derailleur (14) and an electric motor (27) for controlling the derailleur (14), associated directly with the derailleur, and an electric transducer of absolute type

(50, 56), also associated with the derailleur (14) and designed to produce an electric signal indicative of the absolute position of the movable body (17) of the derailleur (14).

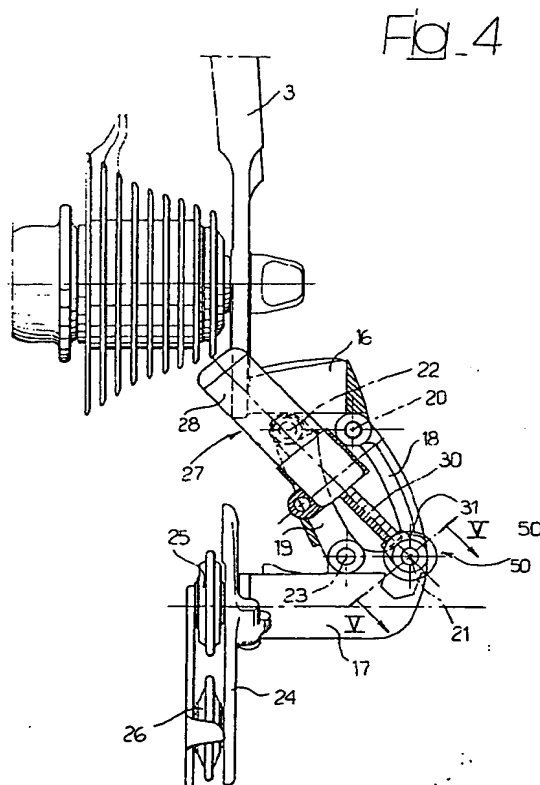


Fig. 4

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## Description

[0001] The present invention refers to a gear shift device for bicycles, of the type comprising:

at least one derailleur, having a first body destined to be attached to a bicycle frame and a second body that can be displaced with respect to the first body to cause the selective engagement of a bicycle chain on a number of sprockets, to achieve the various gears of the device,  
an electric actuator to drive the displacement of the second body of the derailleur,  
electronic control means for controlling said electric actuator,  
manually-operated activating means, connected to said electronic control means, to cause activation of said electric actuator in order to select the required gear,  
means for detecting the position of said second body of the derailleur and for indicating said position to said control means, so as to permit the automatic disabling of the electric actuator once the required position has been reached,  
in which said electric actuator is directly associated with said derailleur.

[0002] A gear shift device of the kind outlined above is described and illustrated in US-A-5 480 356, a patent held by the same applicant.

[0003] Figure 1 of the attached drawings illustrates a racing bicycle, indicated as a whole by reference number 1, comprising a frame 2 constructed, in a well-known manner, of tubular elements comprising stays 3 for supporting the rear wheel 4. Reference number 5 indicates a fork for supporting a front wheel 6, associated with a handlebar 70, which is also made with a tubular structure.

[0004] In its lower part, the frame 2 carries a crankset 7 of substantially conventional type for driving the rear wheel 4 by means of a gear shift device made according to the present invention, indicated globally by the number 8.

[0005] The gear shift device 8 essentially includes a rear assembly 9 and a front assembly 10 comprised, in a well-known manner, of a number of sprockets 11 of various diameters, co-axial with the axle A of the rear wheel 4, and a number of crown wheels 12, also of various diameters, co-axial with the axle B of the bicycle's crankset 7.

[0006] The sprockets 11 and the crown wheels 12 can be engaged selectively by a chain transmission forming a closed ring 13 to achieve the different gear ratios available by means of the gear shift device 8, by activating a rear derailleur 14 forming part of the rear assembly 9 and a front derailleur 15 belonging to the front assembly 10.

[0007] Figure 2 in the enclosed drawings illustrates

the rear derailleur 14 made according to the solution proposed in US-A-5 480 356. The rear derailleur 14 includes a first body 16 that is designed to be attached to the bicycle frame and a second body 17 connected to the first body 16 by means of a parallelogram linkage comprising two arms 18 and 19, the ends of which are articulated in 20, 21 and 22, 23 to the two bodies 16 and 17. The second body 17 includes, in a well-known manner, a rocker arm 24 that carries the chain transmission wheels 25 and 26.

[0008] Reference number 27 indicates an electric actuator, in the form of an electric motor combined with a reduction gear, that is directly incorporated in the derailleur 14 to drive the displacement of the second body 17, and consequently also of the rocker arm 24, through the various engagement positions of the chain 3 with the sprockets 11.

[0009] Figure 3 in the enclosed drawings illustrates the motor cum reduction gear assembly 27 forming the object of the device described in US-A-5 480 356. In said Figure, the body of the motor and reduction gear assembly 27, indicated as 28, is shown on a larger scale and in cross-section. The body 28 contains not only the motor 27, but also an epicycloid reduction gear 29 connected to the shaft coming from the electric motor 27. The epicycloid reduction gear 27 drives the rotation of a screw 30. As shown in Figure 2, the body 28 of the motor and reduction gear assembly is attached with an articulated coupling to the body 16 of the derailleur around an axis 22, while the screw 30 engages a nut screw 31, the body of which is mounted in an articulated manner around an axis 21 on the body 17 of the derailleur. As a result, the motor and reduction gear assembly lies along a diagonal of the parallelogram linkage and the turning of the motor causes a corresponding rotation of the screw 30 by the epicycloid gearing 29, so that the nut screw 31 moves along the screw, leading to an elongation or shortening of the distance between the axes 21 and 22 of the parallelogram linkage.

[0010] As illustrated in Figure 3, the body 28 of the motor and reduction gear assembly also contains a device 32 comprising an encoder, including an optical or magnetic sensor that co-operates in a well-known manner with a disc 34 carried by the screw 30.

[0011] The electric power to the motor and reduction gear assembly 27 is provided by means of a battery 30' (Figure 1) conveniently housed in one of the tubes of the bicycle frame 2 or, alternatively, in one side of the handlebar 70, or inside the container of a microprocessor control unit 40 (only partially visible in Figure 1) that may be attached, for instance, to the bicycle frame in the area of the crankset and is used to control the electric motor 27 on the basis of signals originating from two manually-operated control levers 43 and 44 (which could also be replaced by two buttons) associated, in a well-known manner, with a brake lever 41 (Figure 1). The microprocessor unit 40 is also connected to the encoder 32, which detects the angular position of the

screw 30, and consequently of the rear derailleur, so as to stop the electric motor when a required transmission gear has been reached, said gear being selected by manually operating the levers 43 and 44 (which are operated to shift the chain into higher or lower gears, respectively). The connections between the aforementioned electric components are made, in the case of the above-mentioned well-known solution, by means of wires (not shown in the drawings) conveniently positioned inside the tubes of the bicycle frame 2.

**[0012]** The above-mentioned earlier document describes the opportunity to use an encoder of any kind to provide the means for detecting the position of the second body of the derailleur. In the course of experience gained in the past by the applicant, an incremental encoder was used. With this type of transducer, however, any interruption in the electric power supply to the encoder made it necessary to provide for a procedure for re-calibrating the encoder by making the derailleur move to the position taken as the zero reference by the encoder. It is also important to bear in mind that there is an increasingly-felt need to increase the autonomy of the bicycle with battery-powered systems and therefore to reduce the consumption of electrical energy. For this purpose, control systems can be used that enable energy to be delivered only for the amount of time it takes to satisfy the requirement, after which the system returns to a low-consumption regime. It is also true that, even using an incremental transducer, strategies can be adopted to keep the position value detected memorized at logic level in the control unit. However, this solution may not be sufficient to guarantee the reliability of the transducer, because while it is not being powered the position of the second body of the derailleur may undergo small variations due to the vibrations to which the bicycle is liable while in motion.

**[0013]** The purpose of the present invention is to achieve a gear shift device of the type outlined at the beginning of this description, in which the means for detecting the position of the movable body of the gear always guarantee a reliable and accurate indication of said position, even in the event of an interruption in the power supply, for instance.

**[0014]** With a view to achieving said purpose, the object of the invention is a gear shift device having all the characteristics illustrated at the beginning of this description and characterized, moreover, in that the detection means are comprised of an absolute electric transducer associated with said derailleur and designed to produce an electric signal indicating the absolute position of said second body of the derailleur.

**[0015]** Thanks to said characteristic, the transducer is always capable of providing accurate information on the position of the second body of the derailleur, without requiring any re-calibration procedures after an interruption in the power supply.

**[0016]** In a preferred embodiment, said transducer is a potentiometer comprising at least one electrically-con-

ducting track and a contact sliding on said track due to the effect of any movement of said second body of the derailleur with respect to the first body. In a first example of said embodiment, said potentiometer is of the rotating type, comprising at least one circular track and one rotating movable contact engaged on said track. In a second example, the potentiometer is a sliding potentiometer comprising a cylinder carrying the aforementioned track and a rod carrying the movable contact that slides inside the cylinder.

**[0017]** The absolute transducer can be associated directly with the actuator, or it can be placed between two parts of the derailleur that move in relation to each other as a result of the movement of said second body with respect to the first body. For instance, in the case in which the derailleur has a parallelogram linkage that connects the first body to the second body, a rotating potentiometer can be used in association with any of the articulations of the parallelogram linkage, or a sliding potentiometer can be arranged between two parts of the parallelogram linkage that move in relation to each other, or between the body of the motor and a nut screw that engages a screw driven by the motor.

**[0018]** In the case of the potentiometer being mounted on the shaft of the actuator, it is preferable for it to be placed downstream from a reduction device so that the potentiometer performs less than one turn when the derailleur moves between its two end positions. Otherwise, a reduction gear can be provided in the potentiometer itself or, alternatively, means for counting the turns of the shaft on which the potentiometer is installed can be provided together with the potentiometer.

**[0019]** The absolute transducer may not necessarily be a potentiometer; for instance, it could be a transducer of optical or magnetic type, such as a Hall-effect transducer.

**[0020]** Further characteristics and advantages of the invention will emerge from the description that follows with reference to the attached drawings, which are provided purely by way of example and in no way restrict its scope, in which:

Figure 1 is a perspective view of a racing bicycle, Figure 2 is a perspective view of a rear derailleur made according to the well-known technique, Figure 3 is a perspective exploded view of the motor and reduction gear assembly forming part of the derailleur in Figure 2,

Figure 4 is a partial cross-section of a front view of a first embodiment of a rear derailleur made according to the present invention,

Figure 5 is a cross-section along the line V-V of Figure 4,

Figure 6 is a cross-section along the line VI-VI of Figure 5,

Figure 7 is a perspective view of a second embodiment of a rear derailleur made according to the present invention,

Figure 8 is a front view of a rear derailleur made according to a third embodiment of the present invention,

Figure 9 is a cross-section on an exploded scale of a detail of Figure 8,

Figure 10 is a perspective view of a front derailleur of a bicycle made according to a first embodiment of the present invention,

Figure 11 is a partial cross-section of the front derailleur of Figure 10,

Figure 12 is a view corresponding to the one in Figure 11 that illustrates the front derailleur in a different operating condition, and

Figures 13 and 14 illustrate a variant of the front derailleur illustrated in Figures 11 and 12.

[0021] In Figure 4 the parts corresponding to the ones illustrated in Figure 2 are indicated by the same reference number. The general arrangement of the rear derailleur illustrated in Figure 4 is substantially the same as the one illustrated in Figure 2. Here again, the motor and reduction gear assembly has a body 28 articulated in 22 to the first body 16 of the derailleur and controls a screw 30 that engages a nut screw 31 articulated in 21 to the second body 17 of the derailleur. In the case of Figure 4, however, the means for detecting the position of the second body 17 are comprised not of an encoder associated with the motor 27, but of a transducer 50 mounted in line with the articulation 21 of the parallelogram linkage. To be more specific, the transducer 50 is an absolute transducer, i.e. designed to produce an electric output signal indicating the absolute position of the second body 17. In the embodiment of Figure 4, the transducer 50 is comprised of a rotating potentiometer capable of detecting the absolute angular position of the second body 17 with respect to a pin 51 (see Figures 5 and 6) which achieves the articulation of the body 17 on the arm 18 of the parallelogram articulated around the axis 21. Said pin 51 rotates freely with respect to the body 17 and is rigidly connected to the arm 18 of the parallelogram linkage, so a certain relative rotation of the pin 51 around the body 17 unequivocally corresponds to a certain position of the body 17. As shown in Figures 5 and 6, the transducer 50 includes two circular electric tracks 52, both supported by the body 17 lying coaxially to the axis 21, and a rotating contact 53, that moves with the pin 51 and has two points of contact 54 (see Figure 6) engaged in sliding contact respectively with the two tracks 52. The two tracks 52 are electrically connected by means of a cable 55 to the power supply and the movable contact 53 is used to close the circuit between the two tracks, and any variation in the position of the movable contact 53 gives rise to a variation in the electrical resistance which can be measured, in a well-known manner, in order to produce a signal indicating the absolute position of the movable body 17.

[0022] Figure 7 illustrates a second embodiment that only differs from the one illustrated in Figure 4 in the fact

that the rotating potentiometer 54 is arranged not in line with the articulation 21, but with another articulation of the parallelogram linkage instead (i.e. articulation 23). Otherwise, the structure of the derailleur and of the potentiometer 50 is identical to the one described with reference to Figures 4-6.

[0023] Figure 8 illustrates a further embodiment in which an absolute transducer is used, comprised of a sliding cylinder-type potentiometer 56. The construction of the potentiometer 56 is schematically illustrated in Figure 9. Said potentiometer includes a cylinder 57 that contains two electric tracks running face-to-face 58, powered by means of a cable 59. Inside the cylinder 57 there is a sliding rod 60 with an element 61 inside the cylinder, rather like a piston, which acts as a movable contact designed to close the circuit by connecting the two tracks 58 together, so that, here again, the electrical resistance of the assembly depends on the position of the rod 60.

[0024] As illustrated in Figure 8, the transducer 56, like the motor 27, also lies substantially along a diagonal of the parallelogram linkage (on an outer side of the parallelogram, where the transducer 56 does not interfere with the motor). The cylinder 57 is articulated in 62 to the fixed body 16, while the rod 60 is articulated in 63 to an appendix 18a on the arm 18 of the parallelogram linkage (similar to one generally used in conventional derailleurs for coupling the flexible control cable).

[0025] Figures 10-12 illustrate a further example of implementation of the invention applied to the case of a front derailleur. Here again, the front derailleur is comprised, in a well-known manner, of a first body 16, designed to be attached in some known manner to the bicycle frame, and a second body 17 shaped according to the conventional method in the form of a fork, to control the selective engagement of the chain on the crown wheels 12 associated with the crankset. The body 17 is also connected to the fixed body 16, again in a well-known manner, by means of a parallelogram linkage comprising two arms 18 and 19, articulated in 20, 21 and 22, 23 respectively to the fixed body 16 and the movable body 17. Moreover, the arm 18 extends, in the case of the present invention, into a lever 60, whose movement is controlled by a motor and reduction gear assembly 27 of the kind described previously, mounted on the fixed body 16 so as to oscillate around an axis 90 parallel to the axes 20-23 of the parallelogram linkage. The motor and reduction gear assembly 27 causes the rotation of a screw 30 that engages a nut screw 31 articulated in 61 to the lever 60. Figures 11 and 12 illustrate the fork-shaped movable body 17 in its two end positions.

[0026] As in the case of the rear derailleur, the position of the movable body 17 is detected, here again, by means of an absolute transducer. In the example of Figures 11 and 12, said transducer is a rotating potentiometer, associated with the articulation 20, and comprising a rotating contact 53 connected to the arm 18 and to the

lever 60, sliding over an arched track 52 on the fixed body 16.

[0027] Finally, Figures 13 and 14 illustrate a variant that is substantially identical to the one illustrated in Figures 11 and 12, except for the fact that in this case a sliding potentiometer is used 56, comprising a rod 60 engaged in sliding contact inside a guide element 57. The construction of the inside of the transducer 56 can be much the same as the one illustrated with reference to Figure 9, in the sense that the rod 60 can carry a movable contact designed to connect two opposite tracks placed on the inside surface of the guide element 57.

[0028] It appears evident from the previous description that the principle lying at the basis of the present invention is that of achieving a motorized gear shift device using a motor directly associated with the derailleur and a transducer for detecting the position of the movable body controlled by the motor, which is a transducer of absolute type, i.e. designed to produce an output signal indicative of the absolute position of the movable body. Although the achievement of said transducer in the form of a potentiometer is preferred, any other type of absolute transducer could also be used.

[0029] For instance, optical or even magnetic (e.g. Hall-effect) types of absolute transducer suitable for producing an output signal indicative of the absolute position of the element detected are also well-known.

[0030] It is equally evident from the preceding description that, thanks to the use of an absolute transducer, the device made according to this invention is always capable of providing a reliable and accurate indication of the position of the element being displaced, regardless of any interruptions in the power supply, or any bumping or vibrations that the device may suffer when the bicycle is in motion.

[0031] It is also clear that the positioning of the absolute transducer can vary considerably with respect to the one described and illustrated here by way of example. As we have seen in the case of a derailleur with a parallelogram linkage, the transducer can be placed in line with any of the articulations of the parallelogram linkage, or it can be placed between any two parts of the derailleur that move in relation to each other as a result of any displacement of the movable body of the derailleur. Alternatively, the transducer can be associated directly with the controlling motor cum reduction gear assembly. Obviously, the signal from the transducer is more accurate when the latter is mounted as close as possible to the element it monitors, so that its signal is not influenced by any drive elements or by the corresponding slack.

[0032] Finally, as concerns the electric control motor, this can obviously be made in any well-known manner. For instance, the motor can be a dc motor with brushing contacts, an ultrasonic motor, a stepping motor, or a brushless motor.

[0033] The electric connections between the component parts of the device made according to this invention

can also be achieved with a wireless type of technology, using transmitter and receiver devices associated with the various components.

[0034] Of course, without prejudice to the principle of the invention, the construction details and types of implementation can vary considerably with respect to the version described and illustrated here merely by way of example, without departing from the context of the present invention.

## Claims

### 1. Gear shift device for bicycles, comprising:

at least one derailleur (14, 15), having a first body (16) designed to be attached to a bicycle frame (2), and a second body (17) that can be displaced with respect to the first body (16) to cause the selective engagement of the bicycle chain (13) on a number of sprockets (11, 12) to achieve the various gear ratios of the device, an electric actuator (27) to cause the movement of the second body (17) of the derailleur, electronic control means (40) for governing said electric actuator (27), manually-operated activating means (43, 44) connected to said electronic control means (40) for causing activation of said electric actuator (27) in order to select the required gear, means (50) for detecting the position of said second body (17) of the derailleur and for signaling said position to said control means (40) so as to enable the electric actuator (27) to be disabled automatically once the required position has been reached, in which said electric actuator (27) is associated directly with said derailleur (14, 15),

characterized in that said detection means are comprised of an absolute electric transducer (50) associated with said derailleur (14, 15) and designed to produce an electric output signal indicative of the absolute position of said second body (17) of the derailleur.

2. Gear shift device according to claim 1, characterized in that said derailleur is the rear derailleur of a bicycle, including a parallelogram linkage (18, 19) that connects said second body (17) to said first body (16) and that said electric actuator (27) has its axis arranged along a diagonal of the parallelogram linkage, to vary the relative distance between two opposite angles of the parallelogram.

3. Gear shift device according to claim 1, characterized in that said derailleur is a front derailleur of a bicycle, including a parallelogram linkage (18, 19)

- that connects said second body (17) to said first body (16) and that said electric actuator (27) is carried by said first body (16) and is designed to drive a lever (60) connected to an arm (18) forming part of said parallelogram linkage (18, 19).
4. Gear shift device according to claim 3, characterized in that said electric actuator (27) is mounted on said first body (16) so that it can turn around an axis (90) parallel to the axes of articulation of the parallelogram linkage.
  5. Gear shift device according to claim 2 or 3, characterized in that said transducer (50) is a potentiometer comprising at least one electrically-conducting track (52, 58) and a movable contact (53, 61) that moves along said track (52, 58) due to the effect of any movement of said second body (17) of the derailleur with respect to the first body (16).
  6. Gear shift device according to claim 5, characterized in that said transducer is a rotating potentiometer (50), comprising at least one circular track (52) and one rotating movable contact (53) engaged on the former.
  7. Gear shift device according to claim 5, characterized in that said transducer is a sliding potentiometer (56) comprising a cylinder (57) carrying the aforementioned track (58) and a rod (60) carrying a movable contact (61) sliding inside the cylinder.
  8. Gear shift device according to claim 2 or 3, characterized in that said electric actuator (27) includes an electric motor and that said absolute transducer (50) is associated directly with the shaft of said electric motor (27).
  9. Gear shift device according to claim 2 or 3, characterized in that said absolute transducer (50) is placed between two parts of the derailleur that move in relation to each other as a result of the displacement of said second body (17) with respect to the first body (16).
  10. Gear shift device according to claim 6, characterized in that said rotating potentiometer (50) is associated with an articulation of the parallelogram linkage.
  11. Gear shift device according to claim 7, characterized in that said sliding potentiometer (56) is arranged substantially along a diagonal of the parallelogram linkage.
  12. Gear shift device according to claim 7, characterized in that said electric actuator (27) comprises an electric motor and that said sliding potentiometer (56) is placed between the body (28) of the motor and a nut screw (31) that engages a screw (30) governed by the motor.
  13. Gear shift device according to claim 1, characterized in that said transducer is an optical transducer.
  14. Gear shift device according to claim 1, characterized in that said transducer is a magnetic transducer.
  15. Gear shift device according to claim 2, characterized in that said electric actuator (27) comprises an electric motor and that said motor (27) has an output shaft connected to said second body (17) by means of a screw/nut-screw transmission (30,31).
  16. Gear shift device according to claim 15, characterized in that the body (28) of the motor (27) is mounted so that it can oscillate in line with an articulation (22) of the parallelogram linkage and the aforementioned nut screw (31) is mounted so that it can oscillate around the opposite articulation (21) of the parallelogram linkage and is engaged by a screw (30) driven by the motor (27).
  17. Gear shift device according to claim 3, characterized in that said electric actuator (27) comprises an electric motor and that said motor (27) has an output shaft connected to said second body (17) by means of a screw/nut-screw transmission (30, 31).
  18. Gear shift device according to any of the previous claims, characterized in that the electric connections between at least some of the components of the device are achieved by means of wireless connections.
  19. Gear shift device according to claim 8, characterized in that the transducer is a rotating potentiometer mounted on the shaft of the electric motor.
  20. Gear shift device according to claim 19, characterized in that a reducer is inserted between the potentiometer and the electric motor shaft so that the potentiometer performs less than one turn when the derailleur moves between its two end positions.
  21. Gear shift device according to claim 19, characterized in that the potentiometer includes a reducer.
  22. Gear shift device according to claim 19, characterized in that a means for counting the number of turns of the motor shaft is associated with the potentiometer.

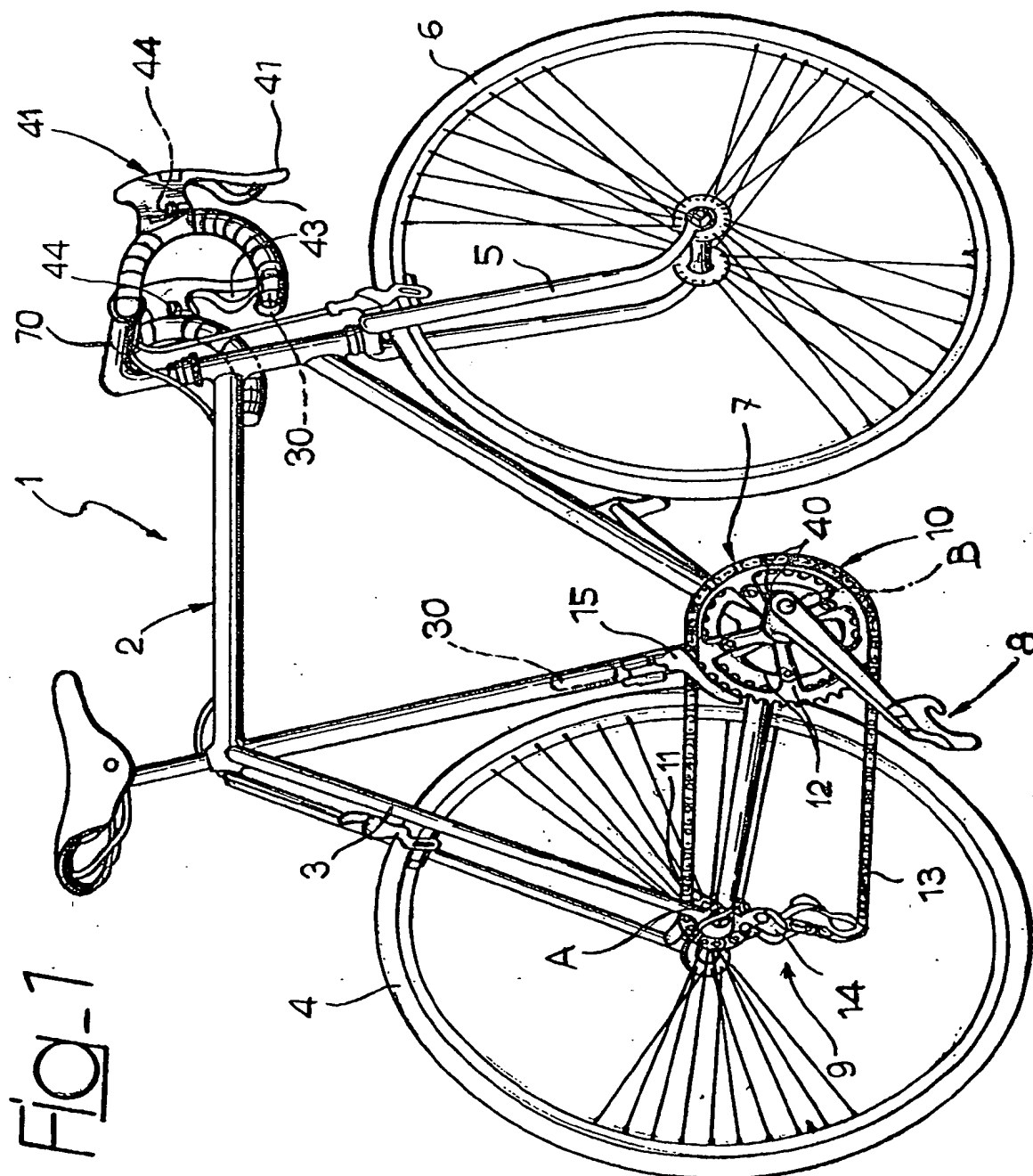
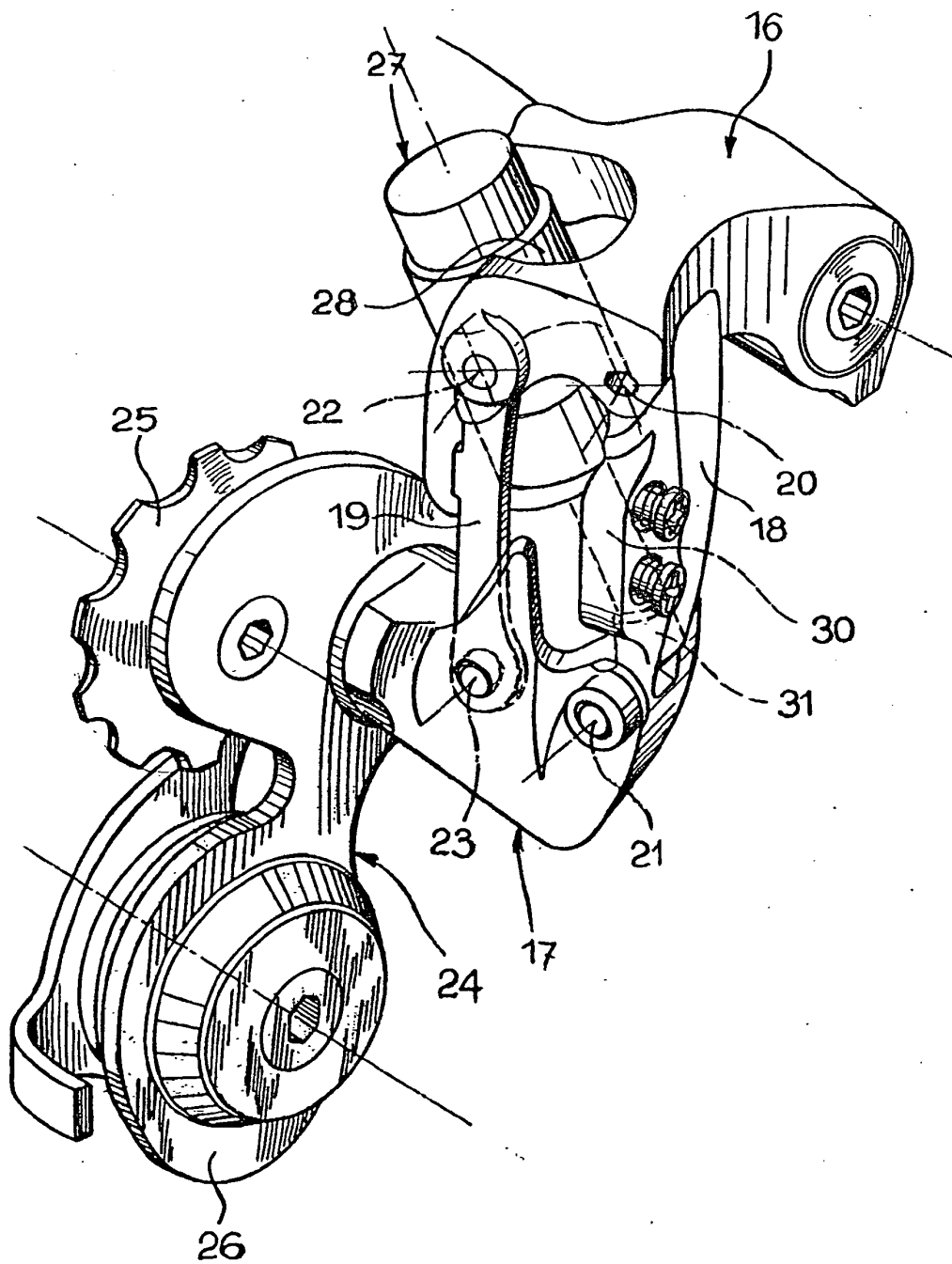


Fig 2





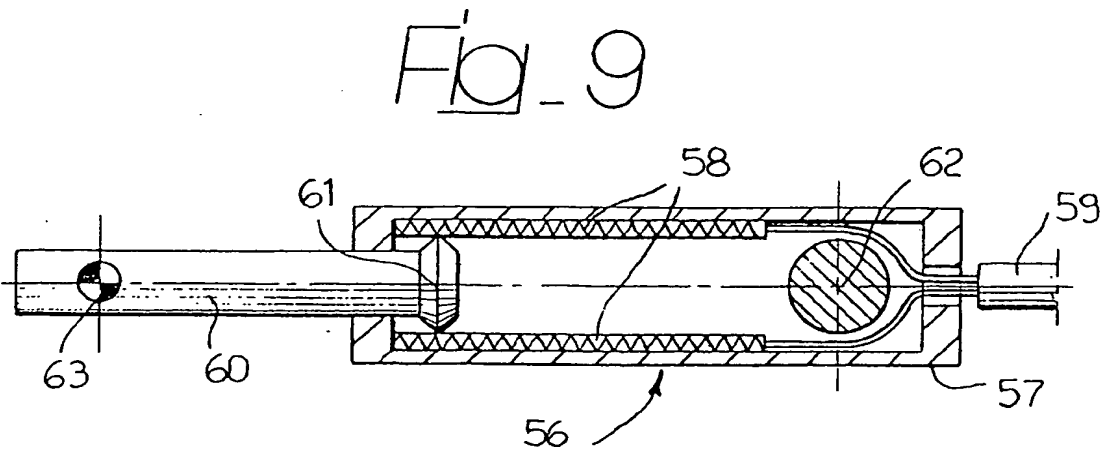
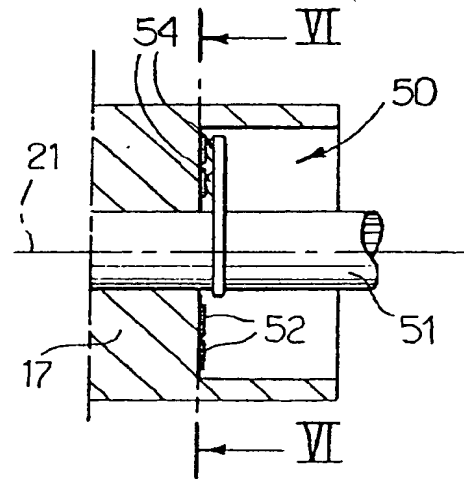
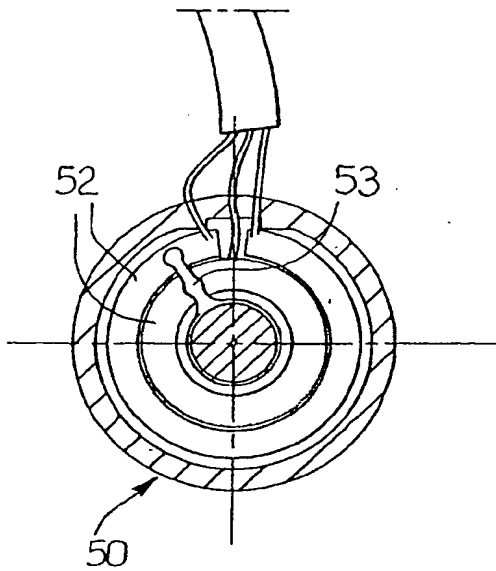
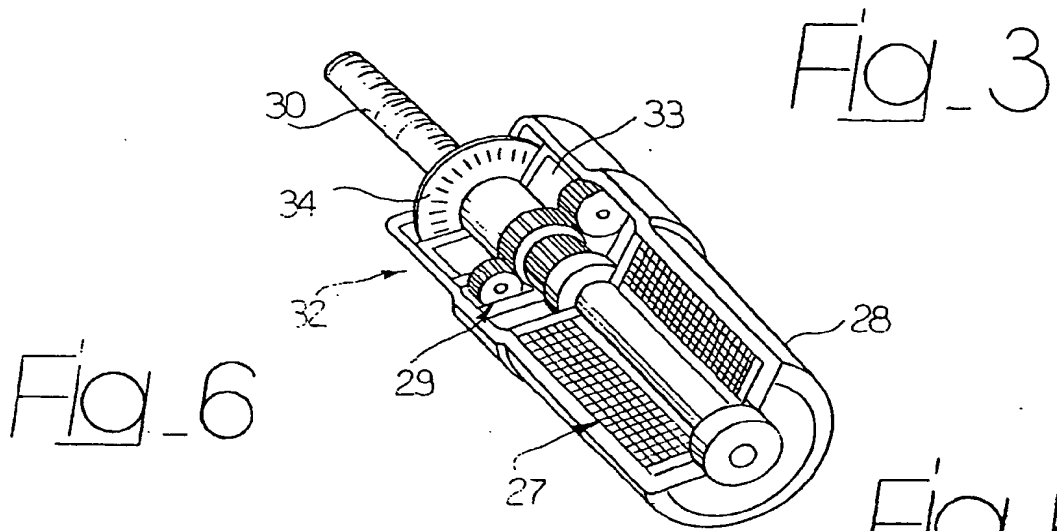


Fig. 4

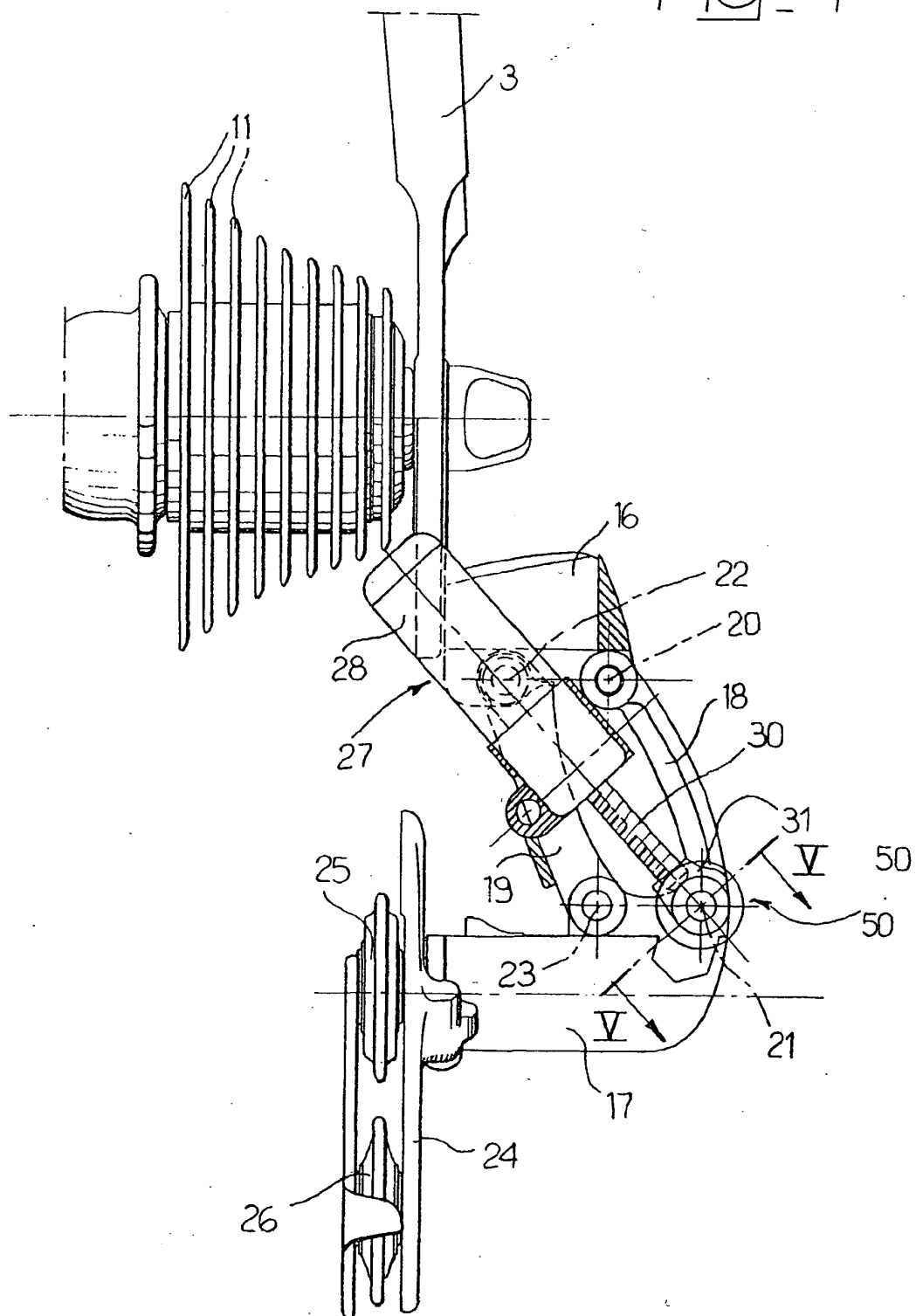


Fig. 7

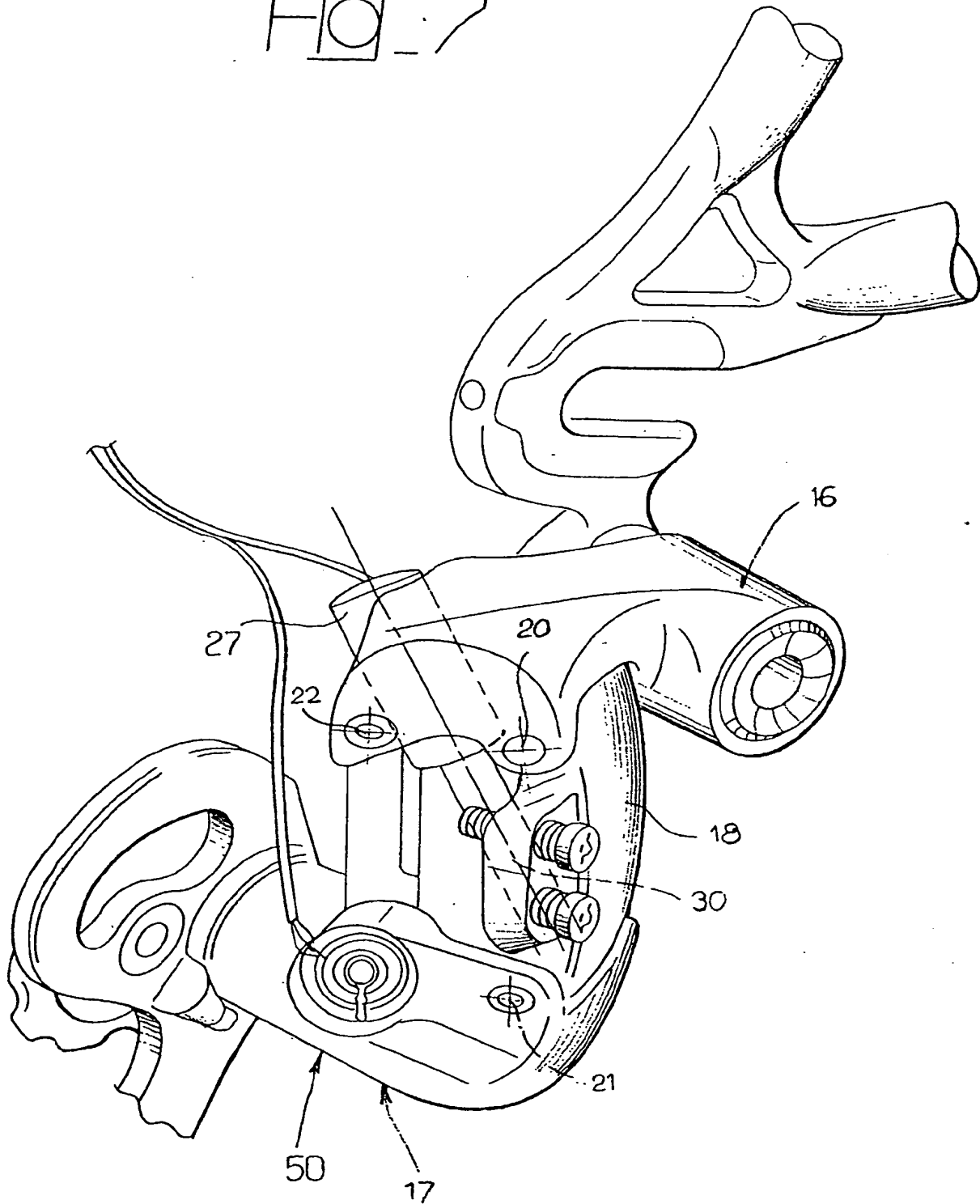


Fig. 8

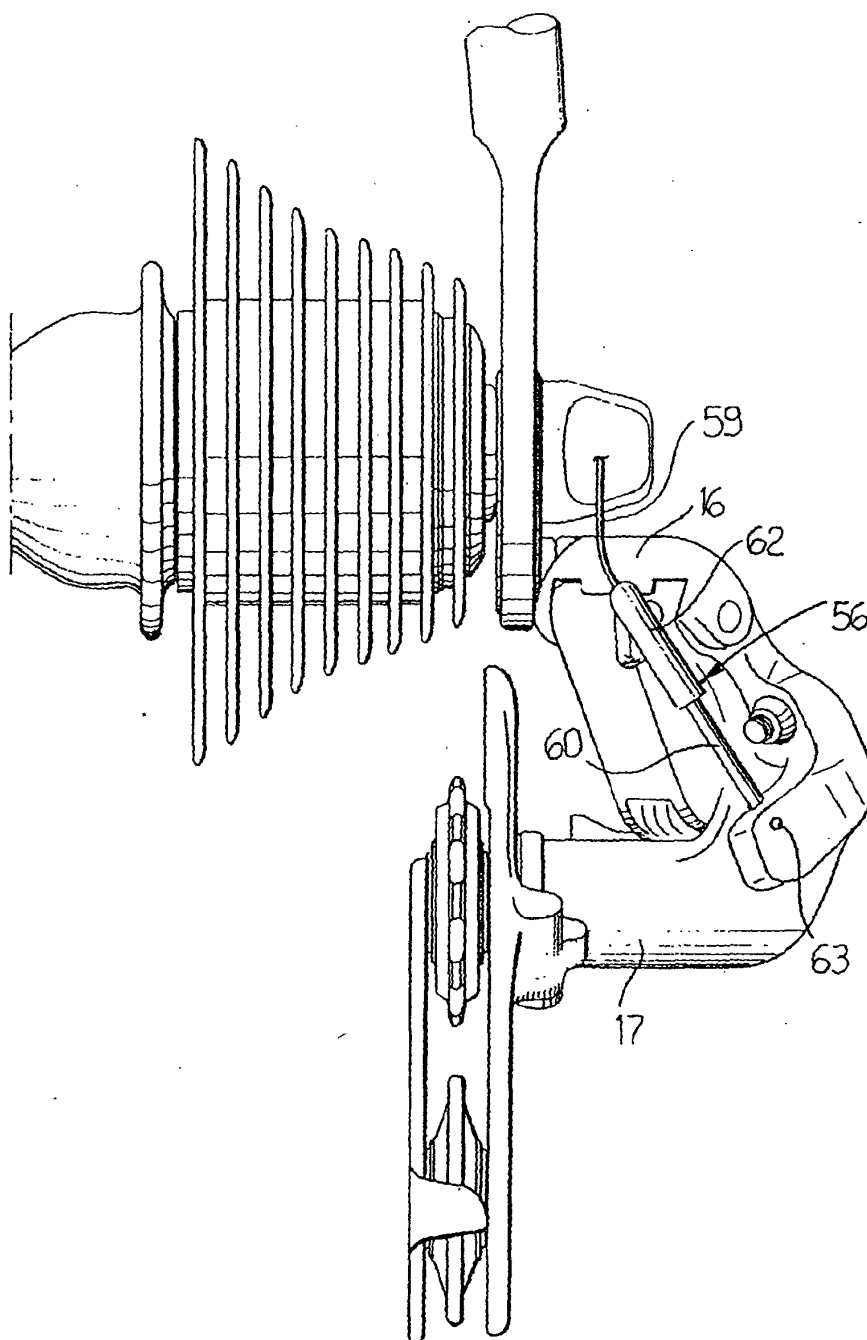
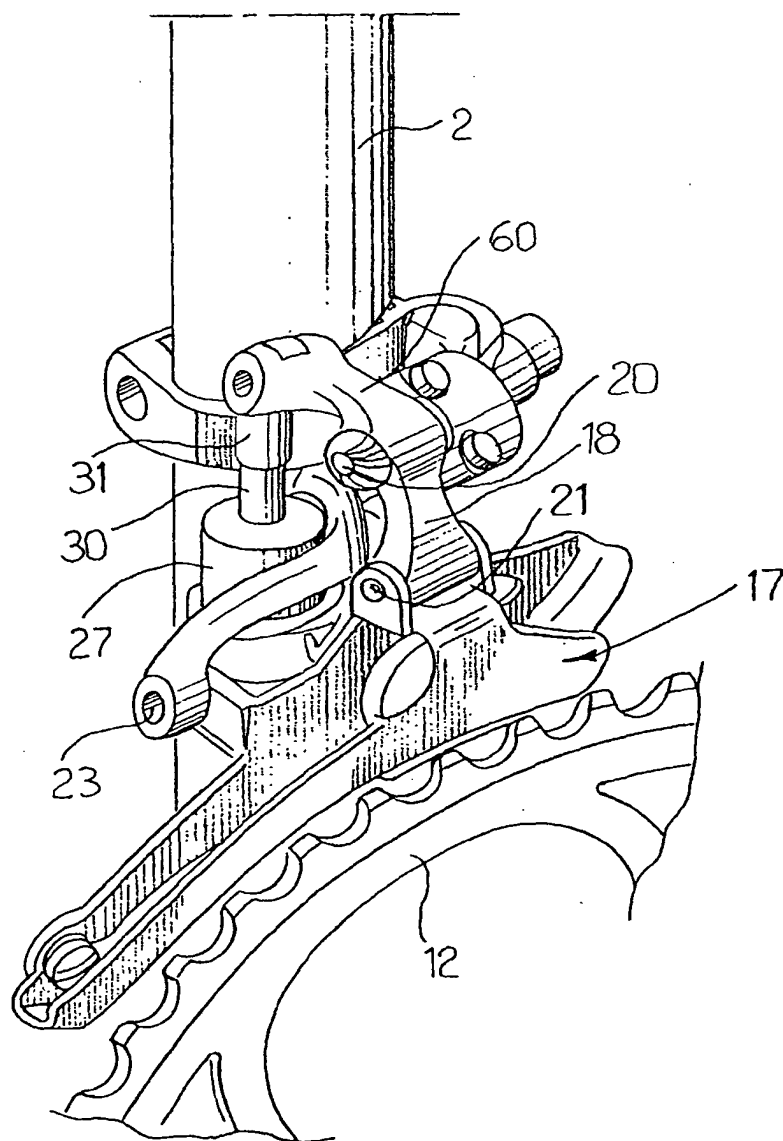
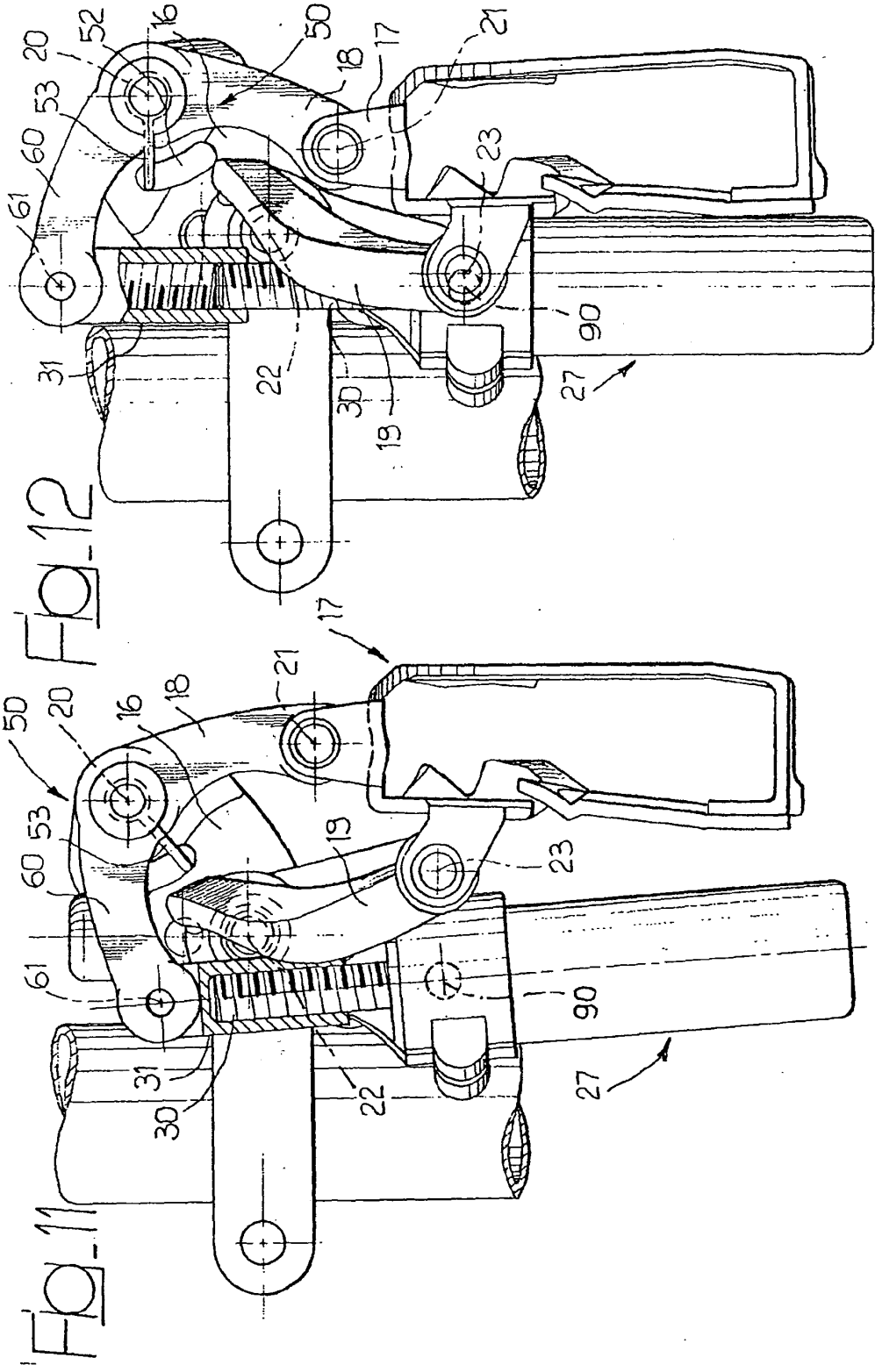


Fig. 10





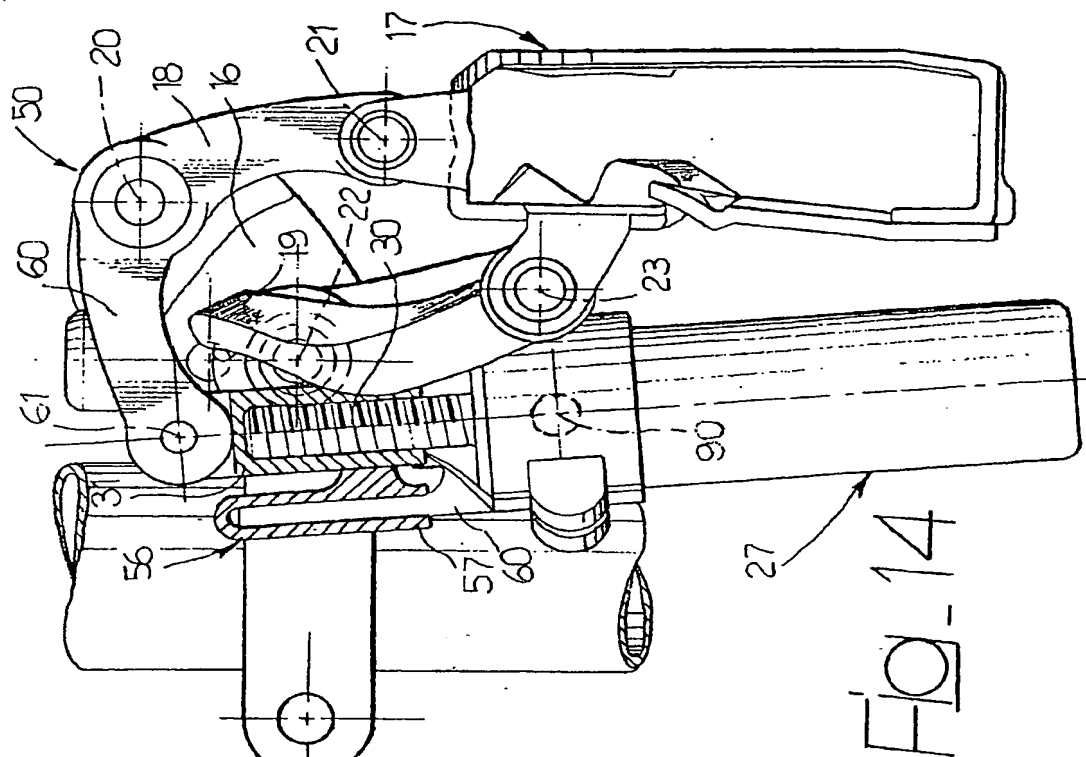


Fig. 13

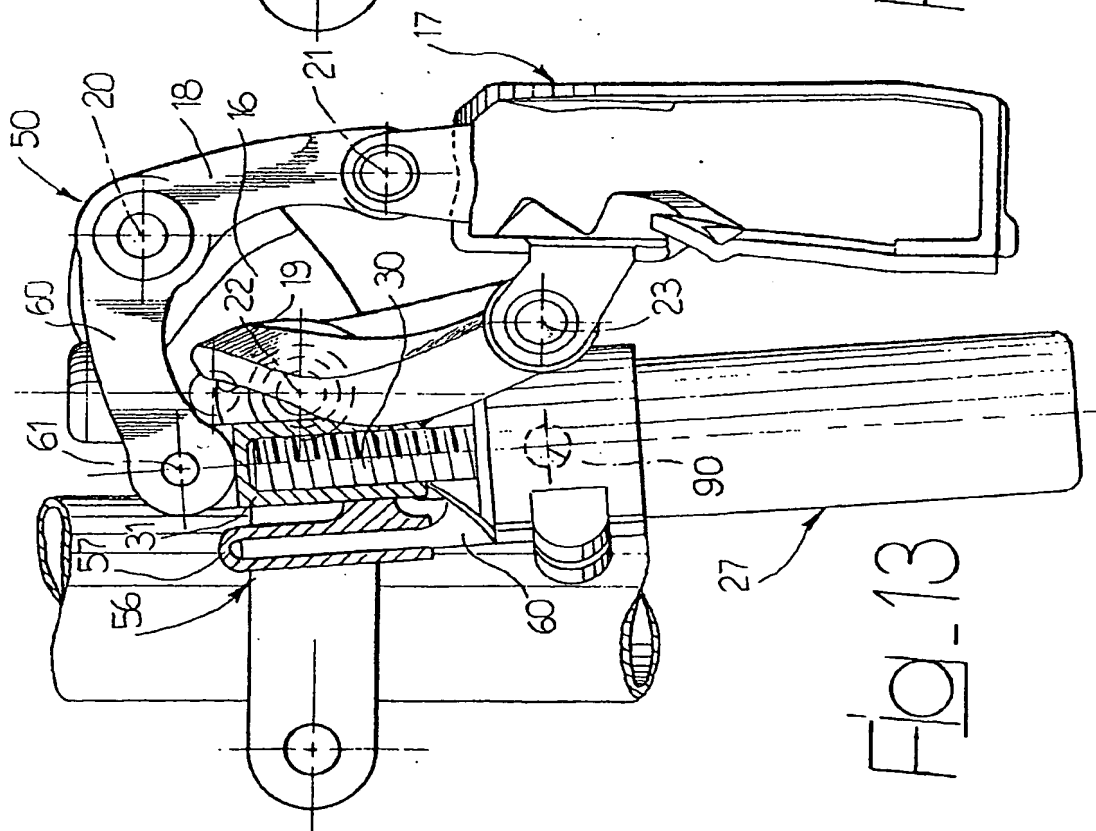


Fig. 14





(19)



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(11)

**EP 1 103 456 A3**

(12)

## EUROPEAN PATENT APPLICATION

(88) Date of publication A3:  
15.01.2003 Bulletin 2003/03

(51) Int Cl.7: B62M 25/08, B62M 9/12

(43) Date of publication A2:  
30.05.2001 Bulletin 2001/22

(21) Application number: 00830723.3

(22) Date of filing: 31.10.2000

(84) Designated Contracting States:  
AT BE CH CY DE DK ES FI FR GB GR IE IT LI LU  
MC NL PT SE  
Designated Extension States:  
AL LT LV MK RO SI

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36100 Vicenza (IT)

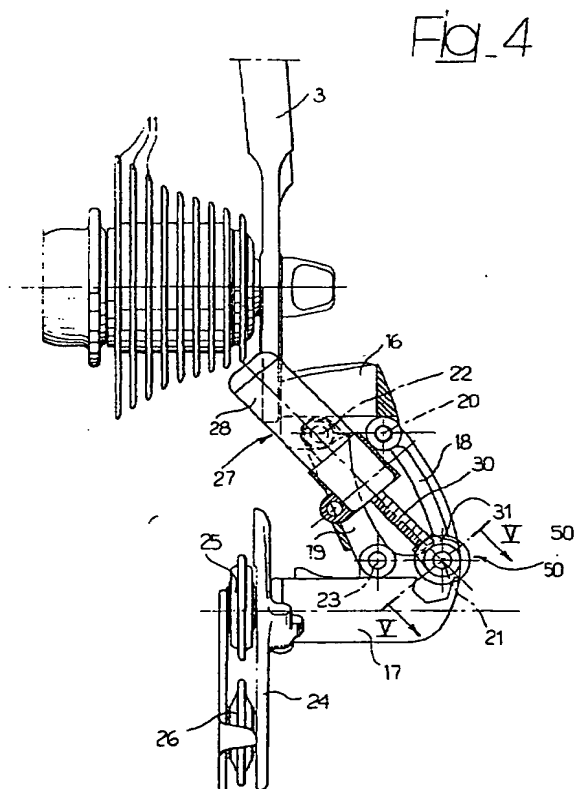
(74) Representative: **Notaro, Giancarlo et al**  
c/o Buzzi, Notaro & Antonielli d'Oulx  
Via Maria Vittoria 18  
10123 Torino (IT)

(30) Priority: 23.11.1999 IT TO991023

(71) Applicant: **CAMPAGNOLO S.R.L.**  
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European Patent  
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# EUROPEAN SEARCH REPORT

Application Number  
EP 00 83 0723

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
D,A	US 5 480 356 A (CAMPAGNOLO) 2 January 1996 (1996-01-02) * the whole document *	1	B62M25/08 B62M9/12
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<p>CATEGORY OF CITED DOCUMENTS</p> <p>X: particularly relevant if taken alone Y: particularly relevant if combined with another document of the same category A: technological background O: non-written disclosure P: intermediate document</p> <p>T: theory or principle underlying the invention E: earlier patent document, but published on, or after the filing date D: document cited in the application L: document cited for other reasons &amp;: member of the same patent family, corresponding document</p>			

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